ECONOMY

IN

HIGHWAY BRIDGE DESIGN.

BY

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THESIS

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Economy in Highway Bridge Design.

In this paper I have attempted to show by actual calculation the relative economy of different designs for highway bridges.

Several types of bridge truss were chosen and an estimate made of the actual weight of iron for the respective types of truss for different spans, with constant capacity and also constant factor of safty. The depth and panel length for the various spans were taken from those most commonly used in practice.

The data for the computation of strains were taken as follows:- Clear roadway for all spans, 16 feet; the weights per lineal foot for lateral systems, floor systems, and for lumber (yellow pine) were taken

from tables in Professor J. A. L. Waddell's treatise on "The Designing of Wrought Iron Highway Bridges"; factor of safety was in all cases taken at 5.

Plates I to XXX are the strain sheets for the different spans of the several types.

Strains were recomputed for all trusses in which the estimated weight varied more than 6 % from the assumed weight, with the exception of the 40 foot span which in the writer's view requires more iron to give it sufficient rigidity than would be required to carry the actual load. All compression members were proportioned by the use of Osborn's Tables.

In determining the weight of iron for details, a percentage of the weight of the truss was used which gave approximately the same weight as that for bridges actually constructed. This percentage

various not only for the different length of spans but for the different modes of making connections as adopted by the different Bridge Companies.

The length of spans given in the strain sheets are:- 40 ft., 60 ft., 80 ft., 100 ft., 120 ft., 140 ft., 160 ft., and 180 ft. The pony truss was used for all the spans from 40 feet to 100 feet, and the high truss was used for all spans except the 40-foot span.

The pony truss is growing into disfavor among many prominent engineers, especially for railroad bridges, the objection being that the length of the top chord as a strut is indefinite. This is very true for railroad bridges where the maximum loading is often applied, and where the deflection of the floor beam will throw the main truss out of a vertical plane, which is of course a very serious condition. But for highway bridges, where the maximum loading is rarely applied, or condition

that extra deep and stiff floor beams are used and riveted to the posts above the chord, and on the further condition that knee braces be employed, the writer sees no good reason why the pony truss may not continue to be used with just as much safty as any other type of truss. If the above conditions are strictly fulfilled, there is no chance for the top chord to be thrown out of a vertical plane, and hence its strut-length may be definitely known.

For all spans under 40 feet, plate-girders should be used instead of trusses, for under these circumstances a truss does not have the proper sigidity unless made very heavy. In the latter case the weight of iron will amount to as much, or even more, than that required for a plate girder, and the cost of construction will exceed that of a girder. The writer has seen a number of small truss bridges from 30 ft. to

40 ft. span, in which only a portion of the web members were ever strained. The rest could not be strained because of nuts working loose or of improper construction. These same bridges vibrated to such a degree, when a train passed over them, as to be noticeable to the unaided eye when at a distance.

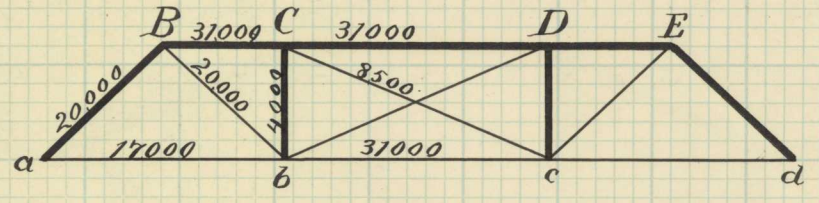
Plates XXXI and XXXII give tables of weights of materials per lineal foot of span for the different types of truss considered, tabulated in order of the length of span, and for any particular span the different type forms are given in the order of their economy except Nos. XI and XII, which should be transposed.

For 40 ft. spans the tables show the Low Pratt Half-Hip Truss to be the most economical, and that its relative economy decreases approximately with the length of span; and in each case is more economical than the Low Pratt Truss. For 60 ft spans and

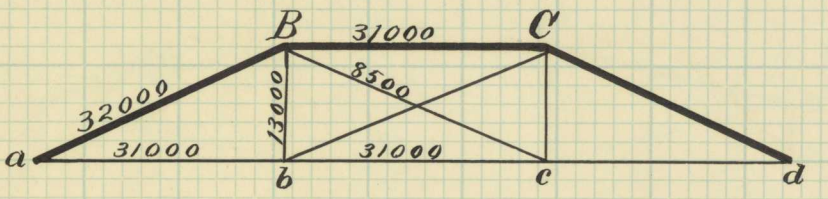
over, the High Pratt Truss is the most economical.

Next to the High Pratt ranks the Parabolic Arch. The Double Parabolic Arch appears to be the least economical type, and all the more so because its weight as given does not include the weight of the struts represented by the dotted lines in the strain sheets. These struts, however, should be put in to prevent longitudinal vibration which is frequently and improperly left to be taken up by the floor system.

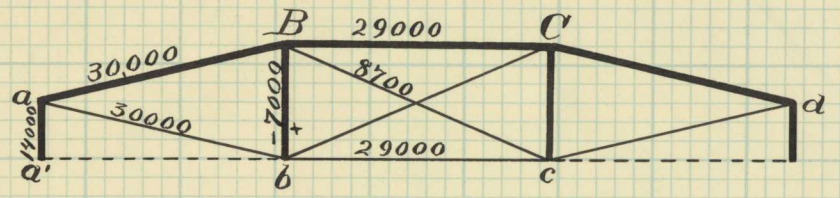
Plate I



Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
B-C	5.7	2-4"×4" L's @ 9.5#	19.0	13.3	256	Span = 40'
C-D	5.7	2-4"×4" L's @ 9.5#	19.0	13.3	256	Roadway = 16'
a-B	4.2	2-4"×3" L's @ 7#	14.0	17.8	249	No of Panels = 3
a-b	1.7	2-1½"×⅜"	5.6	32.0	180	Depth of Truss = 6'
b-c	3.1	2-2"×$\frac{13}{16}$"	10.8	16.0	174	L. L. per sq. ft. of Fl. = 100#
B-b	2.0	2-1" □	6.7	22.0	147	" " " panel per truss = 10667#
C-c	0.8	1-1½" ○	2.9	34.0	100	D. L. " " " " = 2533#
C-b		4-1⅜"×1⅜" L's @ 2.1#	8.4	12.0	100	Factor of Safty = 5
					1462	
					2924	
		Wgt per lin ft. =			73	

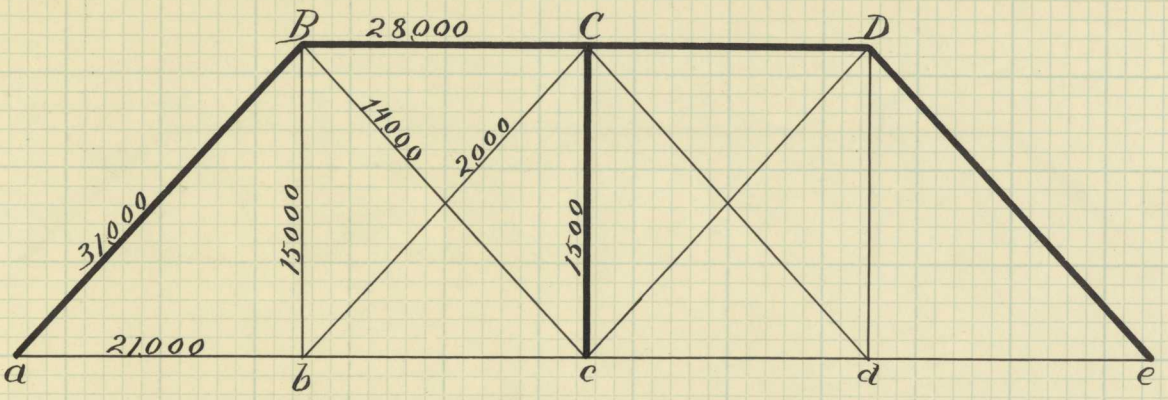


Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
B-C	6.0	2-4"x5" L's @ 10#	20.0	13.3	267	Span = 40'
a-B	6.5	2-4"x5" L's @ 11#	22.0	29.2	642	Roadway = 16'
abc	3.0	2-2" x 3/4"	10.0	48.0	480	No of Panels = 3
B-b	1.3	1-1 3/16" □	4.7	16.0	75	Depth of Truss = 6'
B-c	.85	1-1 1/2" ○	2.95	34.0	101	L. L. per sq. ft. of Fl. = 100#
					1565	" " " panel per truss = 10667#
		Two Trusses =			3130	D. L. " " " " = 2533#
		Wgt. per lin. ft. =			78	Factor of Safty = 5



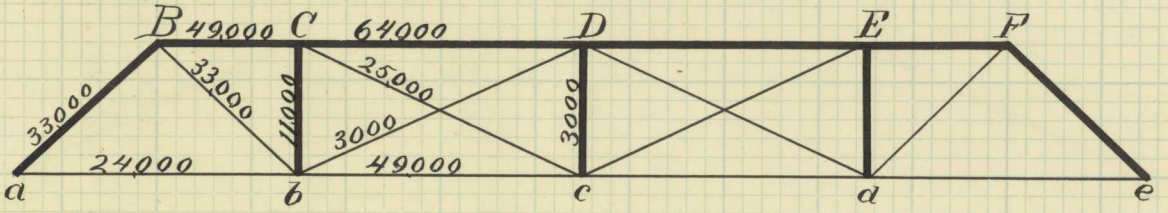
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt	Remarks
a-B	6.5	2-4"x5" L's @ 11#	22.0	27.5	605	Span = 40'
B-C	6.0	2-4"x5" L's @ 10#	20.0	13.3	267	Roadway = 16'
a-b	3.0	2-2"x 3/4"	10.0	32.0	320	No of Panels = 3
b-c	3.0	2-2"x 3/4"	10.0	16.0	160	Depth of Arch = 6'
B-b	2.5	4-1 3/4"x1 3/4" L's @ 2.1	8.4	12.0	101	L. L. per sq. ft. of Fl. = 100#
B-c	0.9	1-1 1/16" O	2.95	34.0	101	" " " panel per truss = 10667#
a-a'	.	2-5" L's @ 8#	16.0	6.0	96	D. L. " " " " = 2533#
					1650	Factor of Safty = 5
					3300	
		Wgt. per lin. ft. =			82.5	

Plate IV



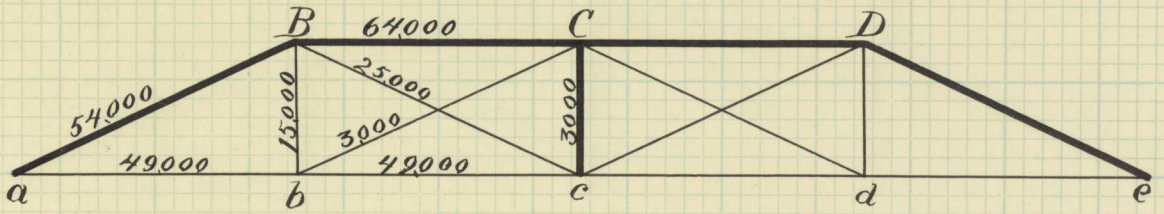
Mem.	Sec.	Material	Wgt	Feet	Total Wgt.	Remarks
B-C	6.4	{Pl. 10" × ¼" 2-5" L's @ 6.5#	21.3	32.0	682	Span = 60'
B-a	7.0	{Pl. 10" × ¼" 2-6" L's @ 7.5#	23.3	44.6	1039	Roadway = 16'
C-c	2.5	4-1¾" × 1¾" L's @ 2.1#	8.4	16.5	139	No of Panels = 4
a-b-c	2.1	2-1" □	6.7	74.0	496	Depth of Truss = 16.5'
B-b	1.5	1-1½" □	5.2	37.0	193	L. L. per sq ft. of Fl. = 100#
B-c	1.4	2-1½" × ½"	5.0	50.0	250	" " " panel per truss = 12000#
b-C		1-¾" ○	1.5	50.0	75	D. L. " " " " = 3150#
					2874	Factor of Safty = 5
					5748	
		Wgt per lin. ft. =			96	

Plate V

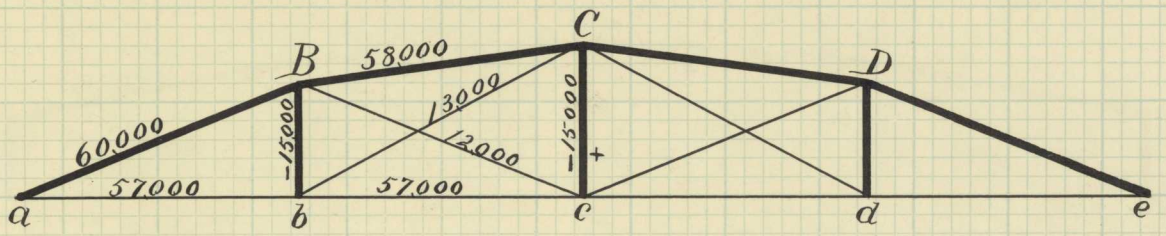


Mem	Sec.	Material	Wgt	Feet	Total Wgt	Remarks
B-C	7.8	{Pl. 12"×¼" 2-7" L's @ 8#	26.0	15.0	390	Span = 60' Roadway = 16' No of Panels = 4 Depth of Truss = 7' L. L. per sq. ft. of Fl. = 100# " " " panel per truss = 12000# D. L. " " " " = 3150# Factor of Safty = 5
C-D	9.0	{Pl. 12"×¼" 2-7" L's @ 10#	30.0	30.0	900	
a-B	7.8	{Pl. 12"×¼" 2-7" L's @ 8#	26.0	20.5	533	
C-b	2.9	4-2"×2" L's @ 2.4#	9.6	14.0	134	
D-c	2.5	4-1¾"×1¾" L's @ 2.1#	8.4	7.0	59	
a-b	2.4	2-2"×⅝"	8.3	35.0	291	
b-c	4.9	2-3"×13/16"	16.3	35.0	569	
B-b	3.3	2-2"×13/16"	10.8	26.0	282	
C-c	2.5	2-2¼"×9/16"	8.4	38.0	310	
b-D	0.3	1-¾" ○	1.5	38.0	57	
					3525	
		Wgt. per lin ft. =			7050 117.5	

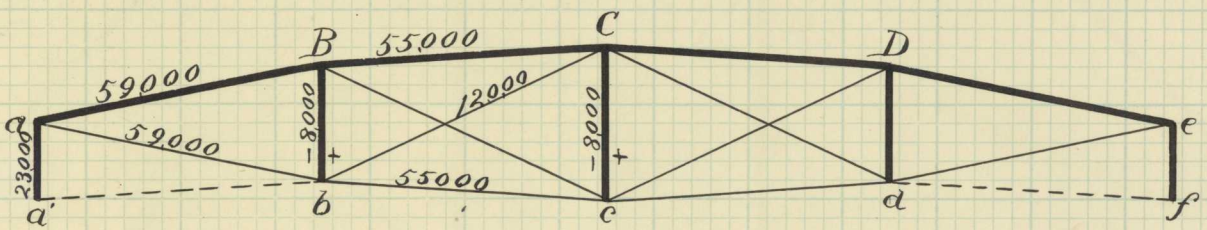
Plate VI



Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
B-C	9.3	{Pl. 12"×¼" 2-7" L's @ 10.5#}	31.0	30.0	930	Span = 60'
a-B	9.0	{Pl. 12"×¼" 2-7" L's @ 10.#}	30.0	33.1	993	Roadway = 16'
C-c	2.5	4-1¾"×1¾" L's @ 2.1#	8.4	7.0	59	No of Panels = 4
a-b-c	4.9	2-3"×13/16"	16.3	70.0	1138	Depth of Truss = 7'
B-b	1.5	1-1½" □	5.2	18.0	94	L. L. per sq. ft. of Fl = 100#
B-c	2.5	2-2¼"×9/16"	8.4	38.0	310	" " " panel per truss = 12000#
b-C		1-¾" ○	1.5	38.0	57	D. L. " " " " = 3150#
					3581	Factor of Safty = 5
					7162	
		Wgt. per lin. ft. =			119.	

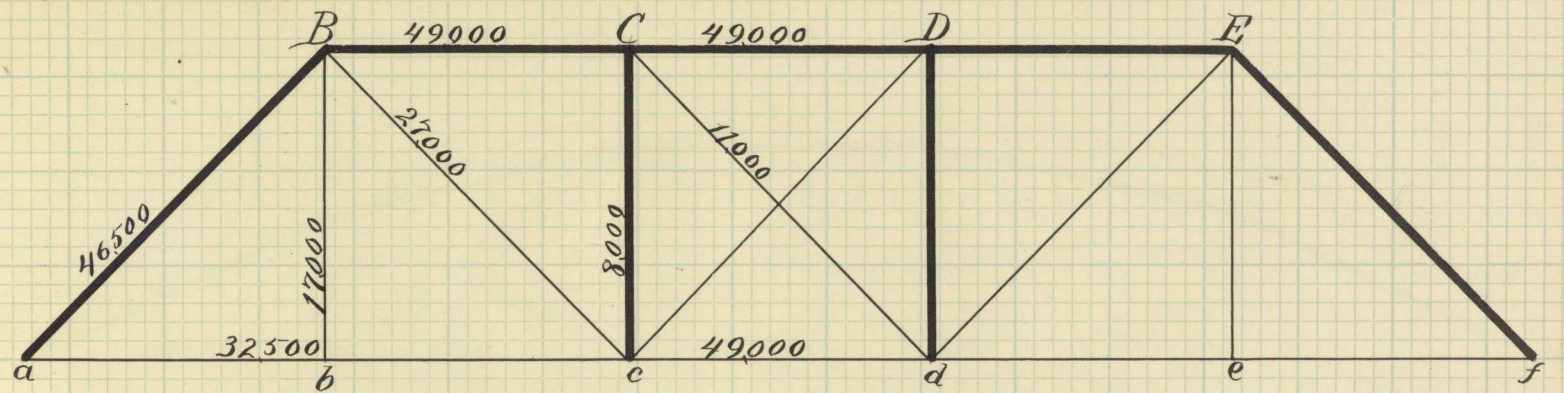


Mem.	Sec.	Material	Wgt	Feet	Total Wgt	Remarks
a-B-C	9.3	(Pl. 12" x 1/4" 2-7" L's @ 10.5#	31.0	62.7	1944	Span = 60'
B-b	2.5	4-1 3/4" x 1 3/4" L's @ 2.1#	8.4	12.0	108	Roadway = 16'
C-c	2.5	4-1 3/4" x 1 3/4" L's @ 2.1#	8.4	8.0	67	No of Panels = 4
a-b-c	5.7	2-3 1/4" x 7/8"	19.0	70.0	1330	Depth of Arch = 8'
B-c	1.2	1-1 1/8" □	3.3	37.0	122	L.L. per sq. ft. of Fl. = 100#
b-C	1.3	1-1 1/8" □	3.3	39.0	129	" " " panel per truss = 12000#
					3700	D.L. " " " " = 3150#
					7400	Factor of Safty = 5
		Wgt per lin. ft. =			123	

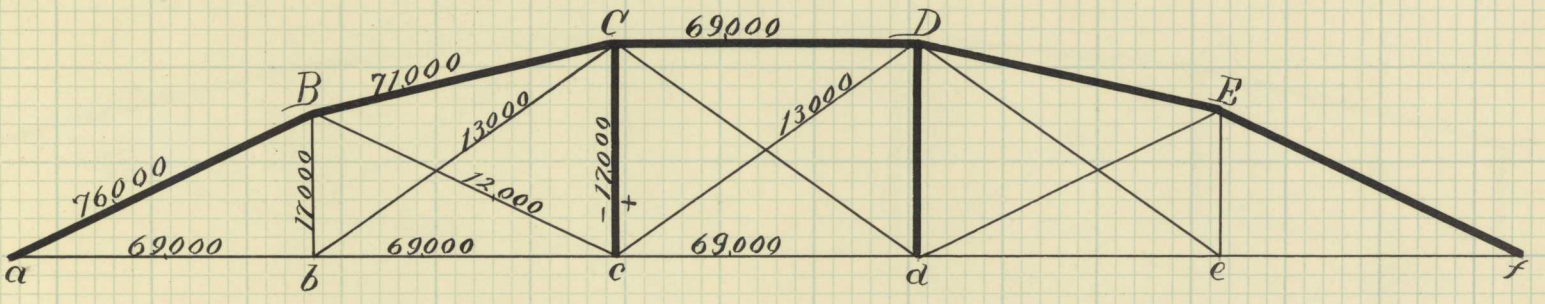


Mem.	Sec.	Material	Wgt	Feet	Total Wgt	Remarks
a-B-C	9.3	Pl. 12"×¼" 2-7" L's @ 10.5#	31.0	60.8	1885	Span = 60'
a-b	6.0	2-3"×1"	20.0	35.6	712	Roadway = 16'
b-c	5.6	2-3"×15/16"	18.8	35.2	662	No of Panels = 4
a-a'		Same as a-B-C	31.0	8.0	248	Depth of Arch = 8'
B-b	2.5	4-1¾"×1¾" L's @ 2.1#	8.4	12.0	101	L.L. per sq. ft. of Fl. = 100#
C-c	2.5	4-1¾"×1¾" L's @ 2.1#	8.4	8.0	67	" " " panel per truss = 12000#
B-c	1.2	1-1⅛" □	4.2	76.0	319	D.L. " " " " = 3150#
					3994	Factor of Safty = 5
					7988	
		Wgt. per lin ft. =			133	

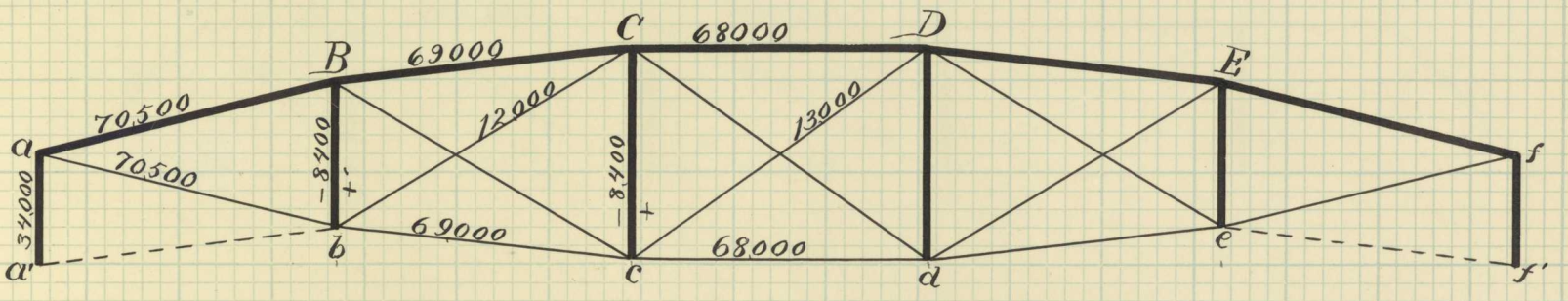
Plate IX



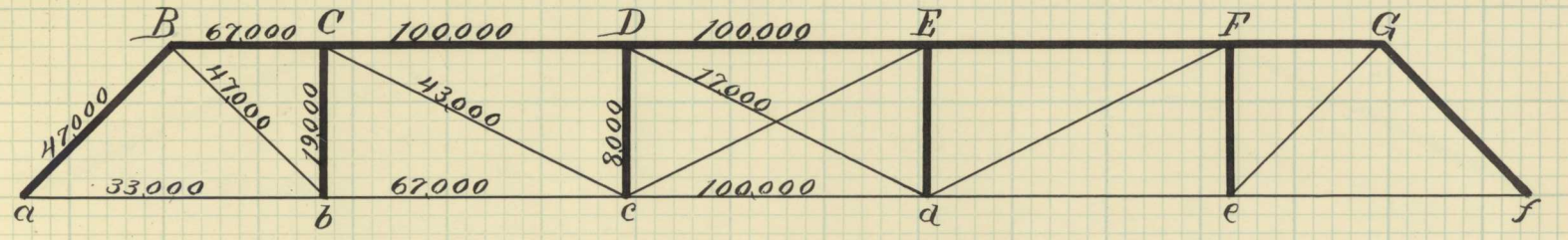
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt	Remarks
B-C-D	8.1	Pl 12" × ¼" 2-7" Ls @ 8.5#	27.0	48.0	1296	Span = 80' Roadway = 16' No of Panels = 5 Depth of Truss = 16.5' L. L. per sq. ft. of Fl. = 100# " " " panel per truss = 12800# D. L. " " " " = 3920# Factor of Safty = 5
a-B	9.0	Pl. 12" × ¼" 2-8" Ls @ 10#	30.0	46.0	1380	
C-c	3.6	4-2½" × 2" Ls @ 8#	12.0	33.0	396	
a-b-c	3.25	2-2¼" × ¾"	11.3	70.0	791	
c-d	4.9	2-2¾" × ⅞"	16.0	18.5	296	
B-b	1.7	2-1½" O	5.9	38.0	224	
B-c	2.7	2-2½" × ⅝"	9.4	51.0	479	
C-d	1.1	1-1" □	2.6	51.0	133	
					4995	
					9990	
		Wgt. per lin. ft. =			125	



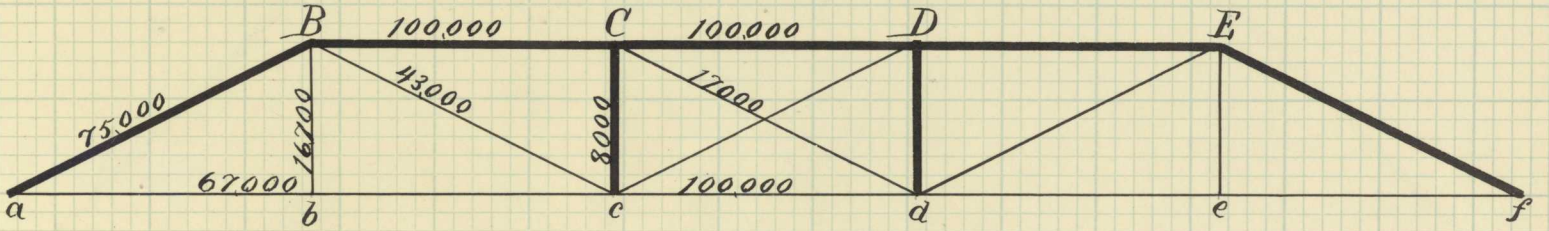
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	11.6	{Pl. 14" × ½" / 2 - 8" L's @ 13.5#}	38.6	35.6	1374	Span = 80'
B-C-D	11.0	{Pl. 14" × ½" / 2 - 8" L's @ 12.5#}	36.6	48.8	1785	Roadway = 16'
C-c	4.2	4 - 2½" × 2" L's @ 3.5#	14.0	24.0	336	No of Panels = 5
a-b-c-d-	7.0	2 - 4" × ⅞"	23.3	93.0	2167	Depth of Arch = 12'
B-b	1.7	2 - 4⅝" □	5.9	20.0	118	L. L. per sq. ft. of Fl. = 100#
B-c	1.2	1 - 1⅛" □	3.8	40.0	152	" " " panel per truss = 12800#
b-C	1.3	1 - 1⅛" □	4.2	44.0	185	D. L. " " " " = 3920#
C-d	1.3	1 - 1⅛" □	4.2	44.0	185	Factor of Safty = 5
					6302	
					12604	
		Wgt. per lin.	ft. =		157.5	



Mem	Sec.	Material	Wgt.	Feet	Total Wgt	Remarks
T. Ch'd	11.0	Pl. 14" x 1/4" 2-8" L's @ 12.5#	36.7	81.2	2980	Span = 80'
B-b	2.5	4-1 3/4" x 1 3/4" L's @ 2.1#	8.4	15.6	131	Roadway = 16'
C-c	2.5	4-1 3/4" x 1 3/4" L's @ 2.1#	8.4	23.0	193	No of Panels = 5
						Depth of Truss = 12'
a-a'		Same as Top Chord	36.7	12.0	440	L. L. per sq. ft. of Fl. = 100#
B. Ch'd	7.0	2-4" x 7/8"	23.3	94.0	2190	" " " panel per truss = 12800#
B-c	1.2	1-1 1/2" □	3.8	84.0	319	D. L. " " " " = 3920#
C-d	1.3	1-1 1/8" □	4.2	46.0	193	Factor of Safty = 5
					6446	
					12892	
		Wgt. per lin. ft. =			161	

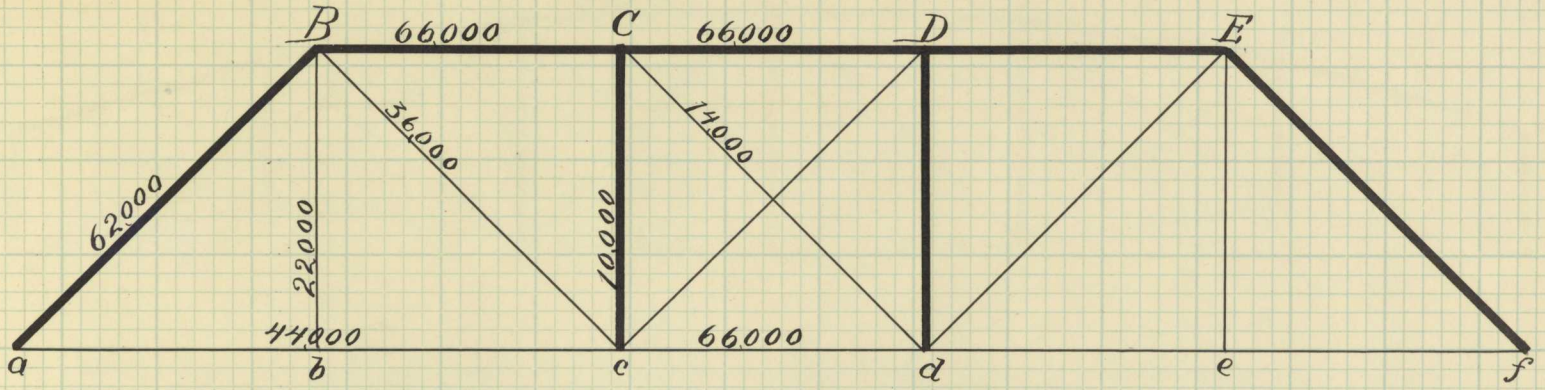


Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
B-a	8.7	{Pl 14"×¼" 2-7" L's @ 8.5#	29.0	22.6	655	Span = 80'
B-C	9.5	{Pl 14"×¼" 2-8" L's @ 10#	32.0	16.0	512	Roadway = 16'
C-D-E	14.4	{Pl 14"×¼" 2-9" L's @ 18#	48.0	48.0	2304	No of Panels = 5
C-b	3.6	4-2"×2½" L's @ 3#	12.0	16.0	192	Depth of Truss = 8'
D-c	2.5	4-1¾"×1¾" L's @ 2.1#	8.4	16.0	134	L. L. per sq. ft. of Pl = 100#
a-b	3.3	2-2¼"×⅜"	11.3	36.0	407	" " " panel per truss = 12800#
b-c	6.7	2-3½"×1"	23.3	36.0	839	D. L. " " " " = 3920#
c-d	10.0	2-4"×1¼"	33.3	18.0	599	Factor of Safty = 5
B-b	4.7	2-2¾"×⅞"	16.0	27.0	432	
C-c	4.3	2-3"×¾"	15.0	40.0	600	
D-d	1.7	2-1¾"×½"	5.8	40.0	232	
					6906	
					13812	
		Wgt. per lin. ft. =			172.5	



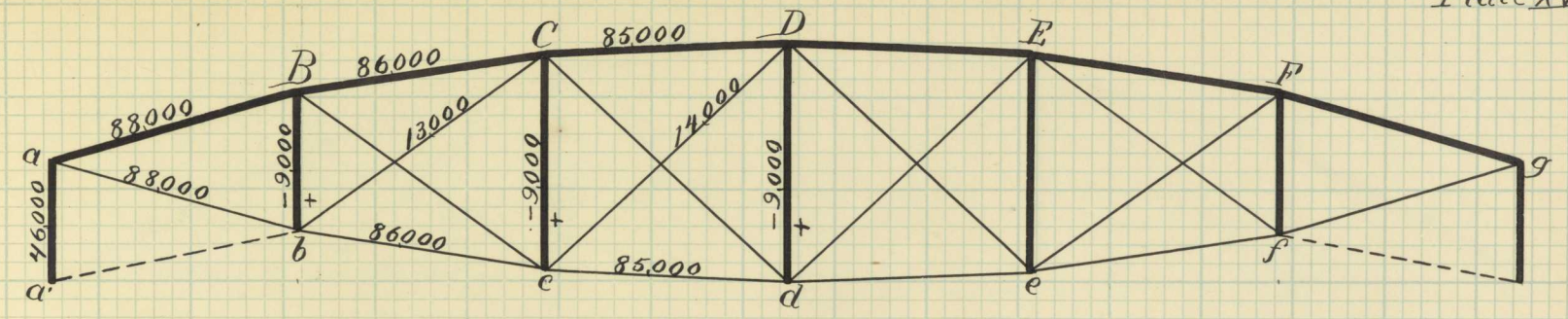
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	11.4	Pl 14" × ¼" 2-8" Ls @ 13.5#	38.6	36.0	1390	Span = 80'
BCD	14.4	Pl 14" × ¼" 2-9" Ls @ 18#	48.0	48.0	2304	Roadway = 16'
C-c	2.5	4-1¾" × 1¾" Ls @ 2.1#	8.4	16.0	134	No of Panels = 5
a-b-c	6.7	2-3½" × 1"	23.3	72.0	1678	Depth of Truss = 8'
c-d	10.0	2-4" × 1¼"	33.3	18.0	599	L. L. per sq. ft of Fl. = 100#
B-b	1.7	1-1¼" □	5.2	20.0	104	" " " panel per truss = 12800#
B-c	4.3	2-3" × ¾"	15.0	40.0	600	D. L. " " " " = 3920#
C-d	1.7	2-1¾" × ½"	5.8	40.0	232	Factor of Safty = 5
					7041	
					14082	
		Wgt. per lin. ft. =			176	

Plate XIV



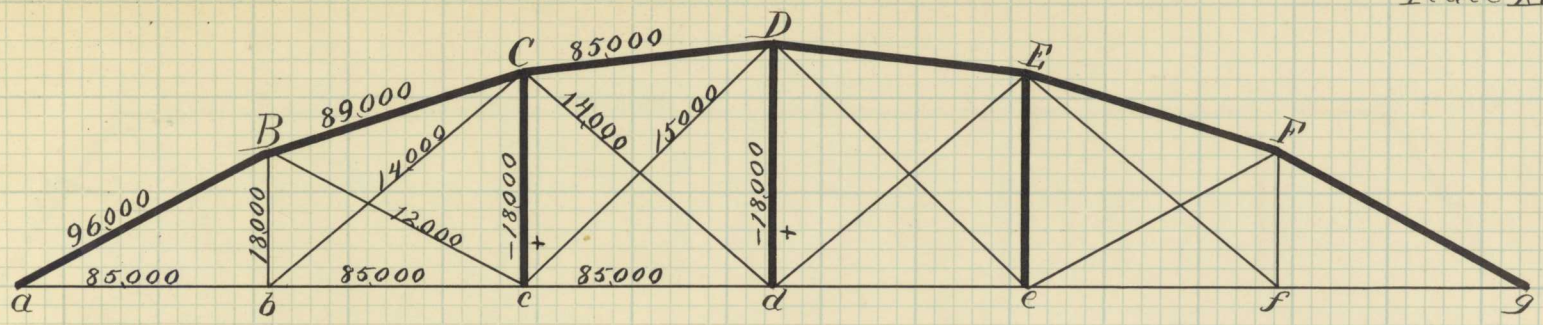
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt	Remarks
a-B	12.2	{Pl. 14" × ½" 2-9" L's @ 14.5#	40.7	56.0	2280	Span = 100'
B-C	12.2	{Pl. 14" × ½" 2-9" L's @ 14.5#	40.7	40.0	1628	Roadway = 16'
C-D	12.2	{Pl. 14" × ½" 2-9" L's @ 14.5#	40.7	20.0	814	No of Panels 5
C-c	4.8	4-2"×3" L's @ 4#	16.0	40.0	640	Depth of Truss = 20'
a-b-c	4.4	2-2½"×1"	15.0	86.0	1290	L. L. per sq. ft. of Pl. = 100#
c-d	6.6	2-3½"×1"	21.7	23.0	499	" " " panel per truss = 16000#
B-b	2.2	2-1⅛" □	5.9	45.0	266	D. L. " " " " = 6000#
B-c	3.6	2-2½"×¾"	12.5	62.0	775	Factor of Safty = 5
C-d	1.4	1-1¼"×1⅛"	4.4	62.0	273	
					8465	
					16930	
		Wgt. per lin. ft. =			169.5	

Plate XV



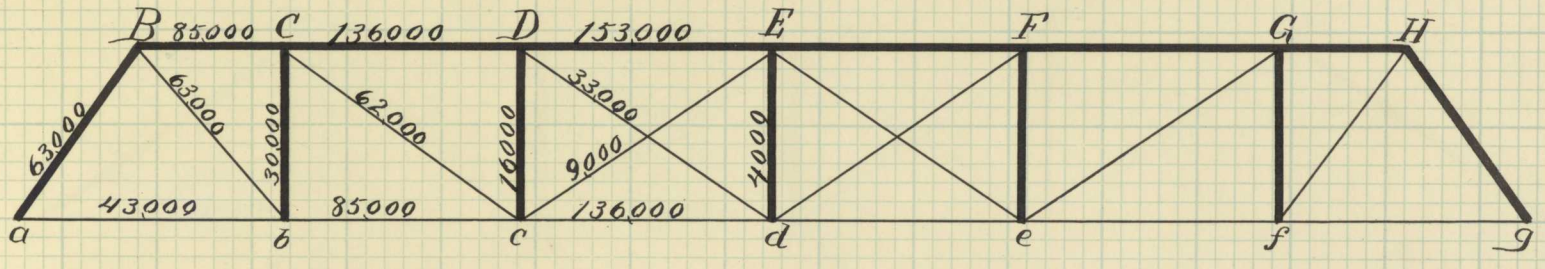
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	14.3	{Pl. 14" × ¼" 2-9" L's @ 18#	47.7	34.8	1660	Span = 100'
B-C-D	13.1	{Pl. 14" × ¼" 2-9" L's @ 16#	43.7	67.0	2928	Roadway = 16'
B-b	2.5	4-1¾" × 1¾" L's @ 2.1#	8.4	18.8	157	No of Panels = 6
C-c	2.9	4-2" × 2" L's @ 2.4#	9.6	29.4	282	Depth of Arch = 16'
D-d	4.2	4-2½" × 2" L's @ 3.5#	14.0	16.0	224	L.L. per sq ft. of Fl. = 100#
a-a'		Same as a-B	47.7	16.0	763	" " " panel per truss = 13333#
a-b	8.8	2-4" × 1⅛"	30.0	40.0	1200	D.L. " " " " = 5000#
b-c-d	8.6	2-4" × 1 1/16"	28.3	77.5	1773	Factor of Safty = 5
B-c	1.3	1-1⅛" □	3.3	92.0	304	
C-d	1.4	2-15/16" O	4.6	100.5	462	
					9753	
					19506	
		Wgt. per lin. ft. =			195	

Plate XVI



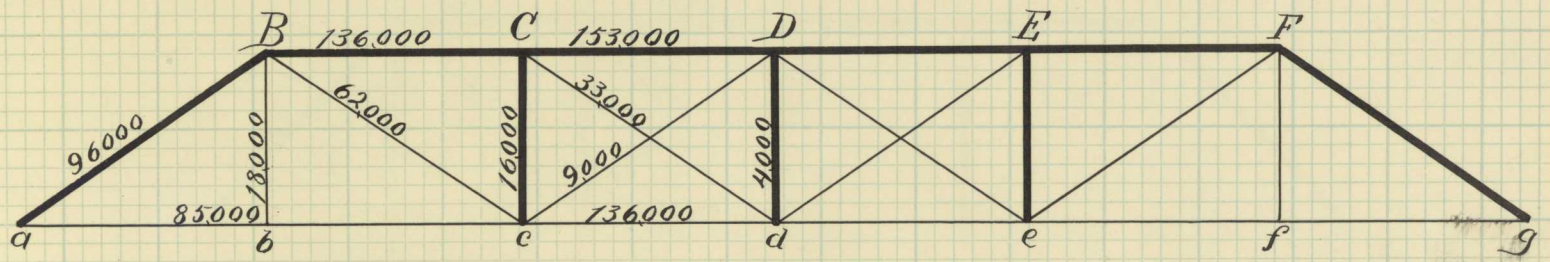
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B-C	14.3	{Pl. 14" × ¼" 2 - 9" L's @ 18#	47.7	73.0	3483	Span = 100'
C-D	13.1	{Pl. 14" × ¼" 2 - 9" L's @ 16#	43.7	33.4	1460	Roadway = 16'
C-c	4.2	4 - 2½" × 2" L's @ 3.5#	14.0	28.6	400	No of Panels = 6
D-d	4.2	4 - 2½" × 2" L's @ 3.5#	14.0	16.0	224	Depth of Arch = 16'
B.Ch'd	8.5	2 - 4" × 1 1/16"	28.4	115.0	3266	L. L. per sq. ft. of Pl. = 100#
B-b	1.8	2 - 1⅛" ○	6.6	23.0	152	" " " panel per truss = 13333#
B-c	1.2	1 - 1 1/16" □	3.0	43.0	129	D. L. " " " " = 5000#
b-C	1.4	2 - 15/16" ○	4.6	98.0	451	Factor of Safty = 5
c-D	1.5	2 - 1" ○	5.2	51.0	265	
					9830	
					19660	
		Wgt. per lin. ft. =			196.5	

Plate XVII

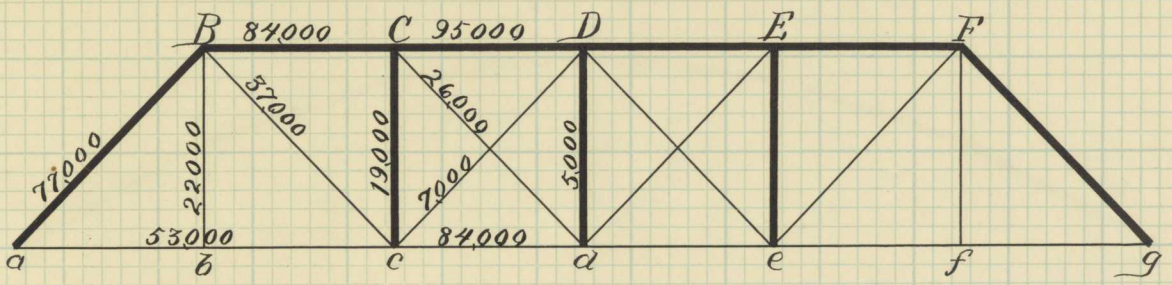


Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	9.5	{Pl. 14" × ¼" 2 - 8" L's @ 10#	31.7	24.6	780	Span = 100'
B-C	11.0	{Pl 14" × ¼" 2 - 8" L's @ 12.5#	36.7	16.6	509	Roadway = 16'
C-B	19.0	{Pl - 14" × ⅜" 2 - 9" L's @ 20#	64.0	33.0	2112	No of Panels = 6
D-E	20.4	{Pl 14" × ⅜" 2 - 9" L's @ 22#	68.0	33.0	2244	Depth of Truss = 9'
C-b	4.8	4 - 2" × 3" L's @ 4#	16.0	18.0	288	L. L. per sq. ft. of Fl. = 100#
D-c	3.6	4 - 2½ × 2" L's @ 3#	12.0	18.0	216	" " " panel per truss = 13333#
E-d	2.5	4 - 1¾" × 1¾" L's @ 2.1#	8.4	9.0	76	D. L. " " " " = 5000#
a-b	4.3	2 - 2¾" × ⅜"	13.8	38.0	524	Factor of Safty = 5
b-c	8.5	2 - 3½" × 1¼"	27.1	38.0	1030	
c-d	13.6	4 - 3½" × 1"	46.7	38.0	1775	
B-b	6.3	2 - 3" × 1"	20.0	30.0	600	
C-c	6.2	2 - 3" × 1"	20.0	43.0	860	
D-d	3.3	2 - 2¼" × ⅜"	11.3	43.0	486	
E-c	0.9	1 - 1⅛" ⌀	3.3	43.0	142	
					11642	
					23284	
		Wgt. per lin. ft =			233	

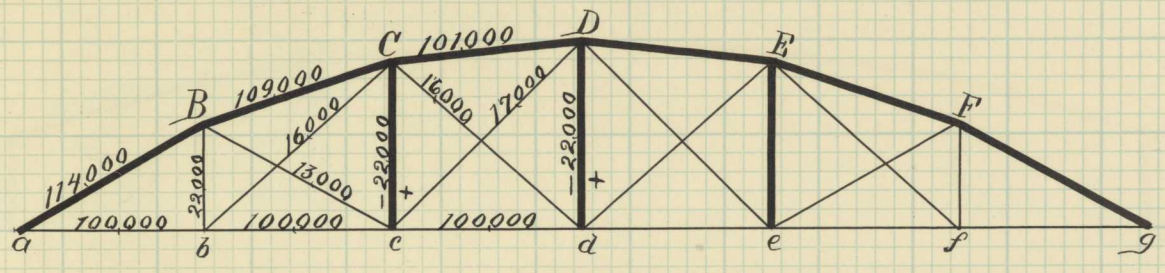
Plate XVIII



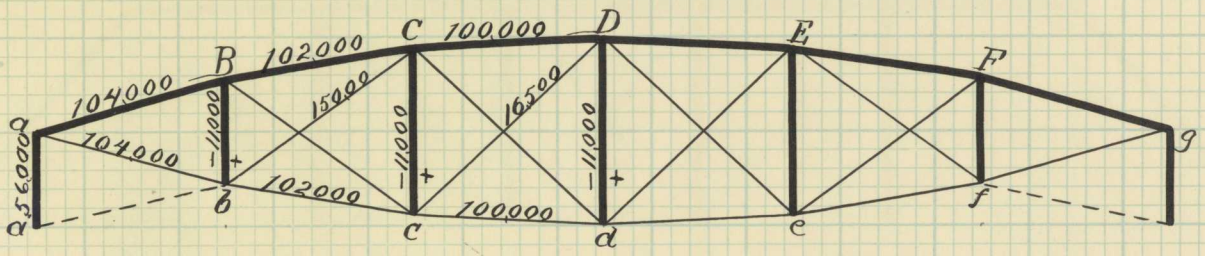
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	14.3	{Pl. 14" × ¼" / 2 - 9" L's @ 18#}	47.6	38.0	1808	Span = 100'
B-C	19.0	{Pl 14" × ⅜" / 2 - 9" L's @ 20#}	64.0	33.0	2112	Roadway = 16'
C-D	20.4	{Pl. 14" × ⅜" / 2 - 9" L's @ 22#}	68.0	33.0	2244	No of Panels = 6
C-c	3.6	4 - 2½" × 2" L's @ 3#	12.0	18.0	216	Depth of Truss = 9'
D-d	2.5	4 - 1¾" × 1¾" L's @ 2.1#	8.4	9.0	76	L. L. per sq. ft. of Fl. = 100#
a-b-c	8.5	2 - 3½" × 1¼"	29.2	76.0	2220	" " " panel per truss = 13333#
c-d	13.6	4 - 3½" × 1"	46.7	38.0	1775	D. L. " " " " = 5000#
B-b	1.8	2 - 15/16" ▭	5.9	22.0	130	Factor of Safty = 5
B-c	6.2	2 - 3" × 1"	20.0	43.0	860	
C-d	3.3	2 - 2¼" × ⅜"	11.3	43.0	486	
D-c	0.9	1 - 1⅛" ○	3.3	43.0	142	
					12069	
					24138	
		Wgt. per lin. ft. =			241.5	



Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	14.3	{Pl. 14" × ¼" / 2-9" L's @ 18#}	47.7	58.0	2767	Span = 120'
B-C-D	13.1	{Pl. 14" × ¼" / 2-9" L's @ 16#}	43.7	80.0	3496	Roadway = 16'
C-c	7.1	4-3"×3" L's @ 5.9#	23.6	42.0	991	No of Panels = 6
D-d	3.6	4-2"×2" L's @ 3#	12.0	21.0	252	Depth of truss = 21'
a-b-c	5.3	2-3¼" × 13/16"	17.6	86.0	1514	L.L. per sq. ft. of Fl. = 100#
c-d	8.4	2-3½" × 1¼"	29.2	45.0	1314	" " " panel per truss = 16000#
B-b	2.2	2-1⅛" □	5.9	48.0	283	D.L. " " " " 6200#
B-c	3.7	2-2½" × ¾"	12.5	64.0	800	Factor of Safty = 5
C-d	2.6	2-2" × 11/16"	9.2	64.0	589	
D-c	0.7	1-15/16" ○	2.3	64.0	147	
					12153	
					24306	
		Wgt. per lin. ft. =			202	

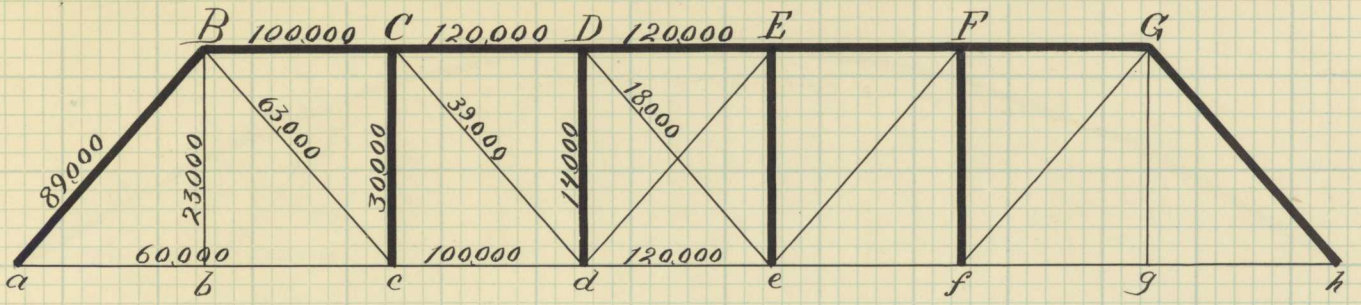


Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B-C	17.0	{Pl. 16" × 5/16" 2-10" L's @ 20#}	56.7	87.8	4971	Span = 120'
C-D	15.5	{Pl. 16" × 5/16" 2-10" L's @ 17.5#}	51.6	40.2	2074	Roadway = 16'
C-c } D-d }	4.2	4-2" × 2½" L's @ 3.5#	14.0	55.6	778	No of Panels = 6
B-Ch'd	10.0	2-4¾" × 1½"	33.6	135.0	4536	Depth of Arch = 20'
B-b	2.2	2-1½" □	6.7	27.2	182	L. L. per sq. ft. of Fl. = 100#
B-c	1.3	1-1⅛" □	4.2	50.8	213	" " " panel per truss = 16000#
b-C-d	1.6	2-1" O	5.2	116.8	607	D. L. " " " " = 6200#
c-D	1.7	2-1½" O	5.9	58.4	344	Factor of Safty = 5
					13705	
					27410	
		Wgt. per lin. ft. =			228	



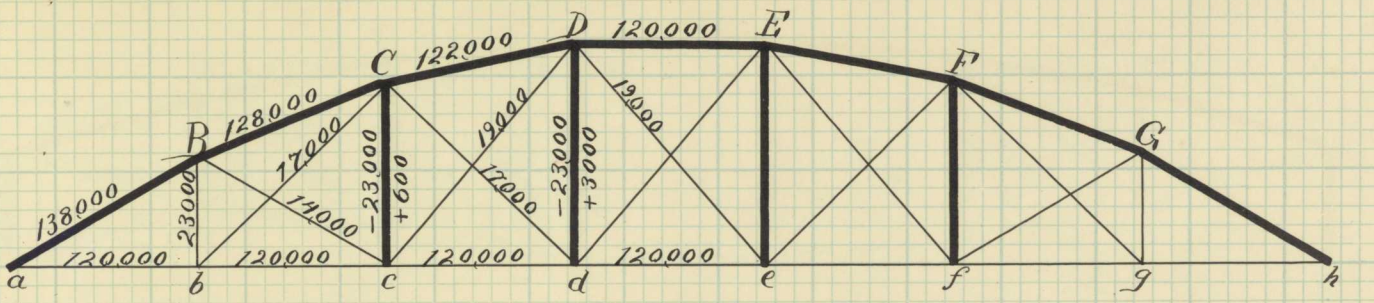
Mem	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	15.5	{Pl. 16" × 5/16" 2-10" L's @ 17.5#}	51.6	41.6	2147	Span = 120'
B-C-D	14.5	{Pl. 16" × 1/2" 2-10" L's @ 17.5#}	48.3	81.0	3912	Roadway = 16'
B-b	2.9	4-2"×2" L's @ 2.4	9.6	22.0	211	No of Panels = 6
C-c, D-d	4.2	4-2 1/2"×2" L's @ 3.5#	14.0	55.5	777	Depth of Arch = 20'
a-a'		Same as a-B	51.6	20.0	1032	L.L. per sq. ft. of Fl. = 100#
B-C-d	10.2	2-4 1/2"×1 1/8"	33.8	138.0	4664	" " " panel per truss = 16000#
B-c	1.5	2-1" ○	5.2	109.5	570	D.L. " " " " = 6200#
C-a	1.6	2-1 1/16" ○	5.9	120.0	708	Factor of Safty = 5
					14021	
					28042	
		Wgt. per lin. ft. =			233.5	

Plate XXII



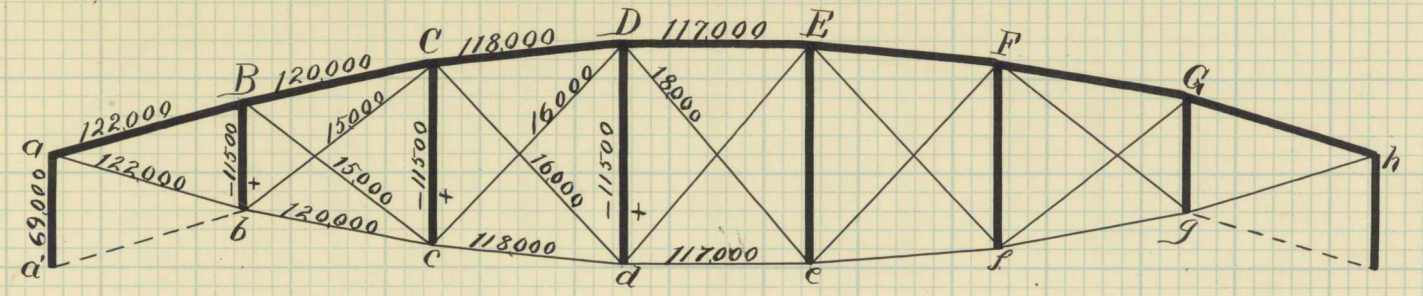
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	16.0	Pl. 16" × ½" 2-10" Ls @ 20#	53.3	61.0	3253	Span = 140'
B-C	14.5	Pl. 16" × ½" 2-10" Ls @ 17.5#	48.3	40.0	1933	Roadway = 16'
C-D-E	17.0	Pl. 16" × 5/16" 2-10" Ls @ 20#	57.0	60.0	3420	No of Panels = 7
C-c	9.6	4-3" × 3½" Ls @ 8#	32.0	46.0	1472	Depth of Truss = 23'
D-d	5.4	4-2½" × 3" Ls @ 4.4#	17.6	46.0	810	L. L. per sq. ft. of Fl. = 100#
a-b-c	6.0	2-3" × 1"	20.0	86.0	1720	" " " panel per truss = 16000#
c-d	10.0	2-4" × 1½"	33.3	45.0	1499	D. L. " " " " = 7000#
d-e	12.0	4-3" × 1"	40.0	23.0	920	Factor of Safty = 5
B-b	2.3	2-1⅛" □	5.9	52.0	307	
B-c	6.3	2-3" × 1/16"	21.2	68.0	1442	
C-d	3.9	2-2½" × ¾"	12.5	68.0	850	
D-e	1.8	2-4⅝" □	4.6	68.0	313	
					17939	
					35878	
		Wgt. per lin. ft. =			256	

Plate XXIII



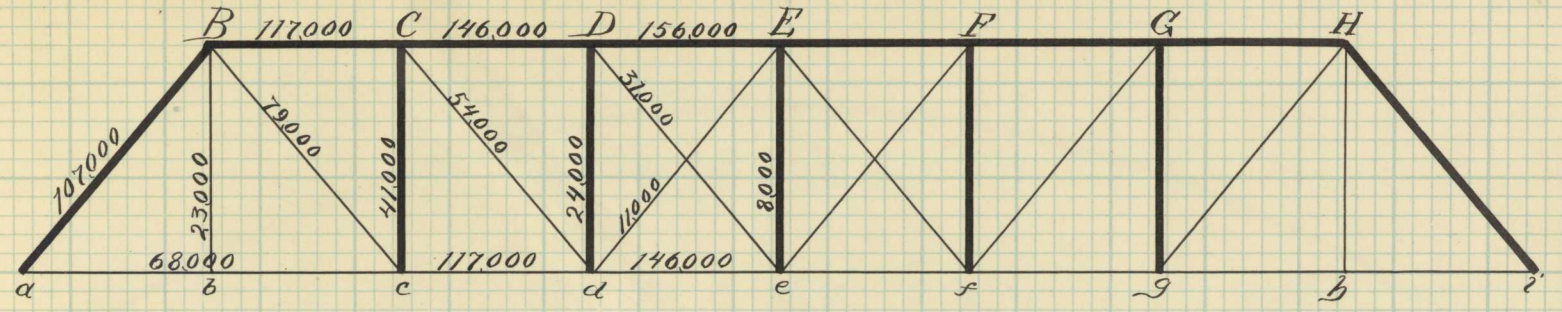
Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B-C	19.8	{Pl. 16" × 3/8" 2-12" L's @ 23#}	66.1	88.6	5857	Span = 140'
C-D-E	18.5	{Pl. 16" × 3/16" 2-12" L's @ 22.5#}	61.7	60.6	3639	Roadway = 16'
C-c } D-d }	4.2	4-2" × 2½" L's @ 3.5#	14.0	85.8	1201	No of Panels = 7
B-C-d	12.0	2-5" × 1 3/16"	39.6	156.0	6078	Depth of Arch = 24'
B-b	2.3	2-1½" □	7.5	28.2	211	L.L. per sq. ft. of Fl. = 100#
B-c	1.4	2-15/16" ○	4.6	51.0	235	" " " panel per truss = 16000#
b-C-d	1.7	2-15/16" □	5.9	121.2	715	D.L. " " " " = 7000#
C-D	1.9	2-1" □	6.7	132.0	884	Factor of Safty = 5
					18820	
					37640	
		Wgt. per lin. ft. =			266	

Plate XXIV

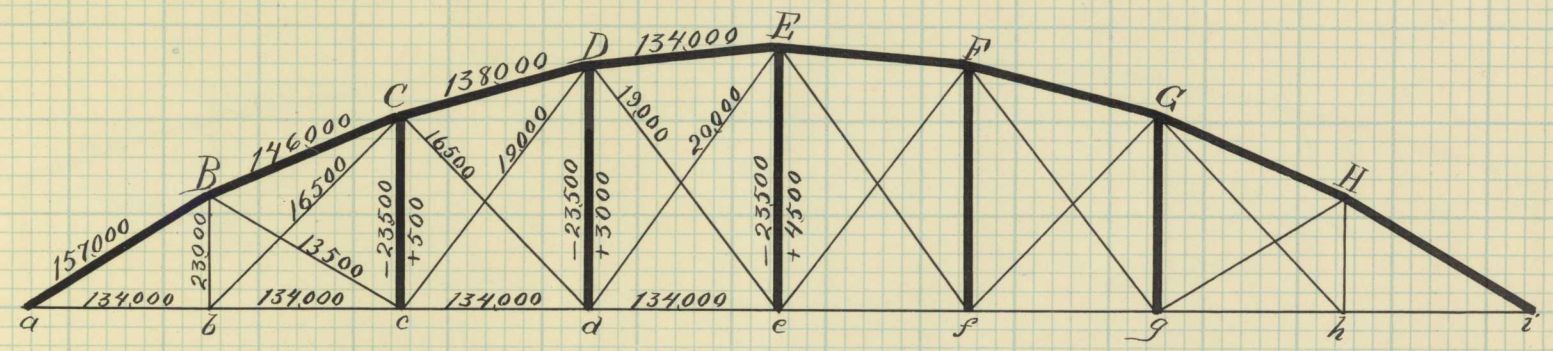


Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
T. Ch'd	18.5	{Pl. 16" × 5/16" 2-12" Ls @ 22.5#}	61.7	143.2	8835	Span = 140'
B-b	2.5	4-1¾" × 1¾" Ls @ 2.1#	8.4	23.6	198	Roadway = 16'
C-c	4.2	4-2½" × 2" Ls @ 3.5#	14.0	39.0	546	No of Panels = 7
D-d	4.8	4-2" × 3" Ls @ 4#	16.0	46.4	742	Depth of Arch = 24'
a-a'		Same as T. Ch'd	61.7	24.0	1481	L. L. per sq. ft. of Fl. = 100#
B. Ch'd	12.0	2-5" × 1 3/16"	39.6	161.5	6396	" " " panel per truss = 16000#
B-c	1.5	2-1" ○	5.2	111.2	578	D. L. " " " " = 7000#
C-d) D-e)	1.6	2-1½" ○	5.9	188.4	1111	Factor of Safty = 5
					19887	
					39774	
		Wgt. per lin. ft. =			284	

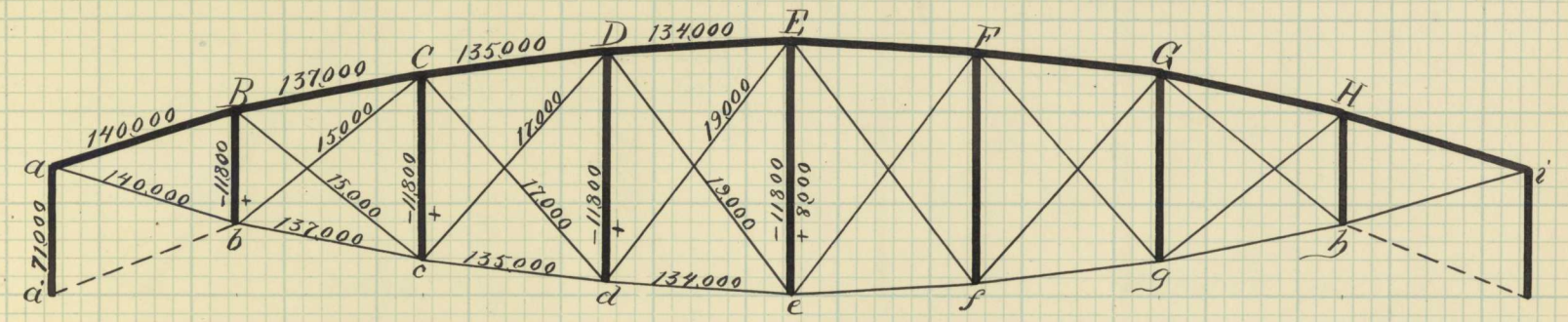
Plate XXV



Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B	18.5	{Pl. 16" × 5/16" 2-12" L's @ 22.5#}	61.7	62.5	3856	Span = 160'
B-C	17.0	{Pl. 16" × 5/16" 2-12" L's @ 20#}	56.7	40.0	2268	Roadway = 16'
C-D	19.5	{Pl. 16" × 3/8" 2-12" L's @ 22.5#}	65.0	40.0	2600	No of Panels = 8
D-E	21.0	{Pl. 16" × 3/8" 2-12" L's @ 25#}	70.0	40.0	2800	Depth of Truss = 24'
C-c	8.4	2-7" L's @ 14#	28.0	48.0	1344	L.L. per sq. ft. of Fl. = 100#
D-d	6.0	2-6" L's @ 10#	20.0	48.0	960	" " " panel per truss = 16000#
E-e	3.6	2-5" L's @ 6#	12.0	24.0	288	D.L. " " " " = 7500#
a-b-c	6.8	2-3½" × 1"	23.3	86.0	2004	Factor of Safty = 5
c-d	11.7	4-3½" × 15/16"	40.6	45.0	1827	
d-e	14.6	4-3½" × 1 1/16"	49.6	45.0	2232	
B-b	2.3	2-1¼" 0	8.2	54.0	442	
B-c	7.9	2-3¾" × 1 1/16"	26.6	68.0	1808	
C-d	5.4	2-3" × ⅞"	17.5	68.0	1190	
D-e	3.1	2-2½" × 5/8"	10.4	68.0	707	
E-d	1.1	1-1" 0	2.6	68.0	177	
					24503	
					49006	
		Wgt. per lin. ft. =			307	

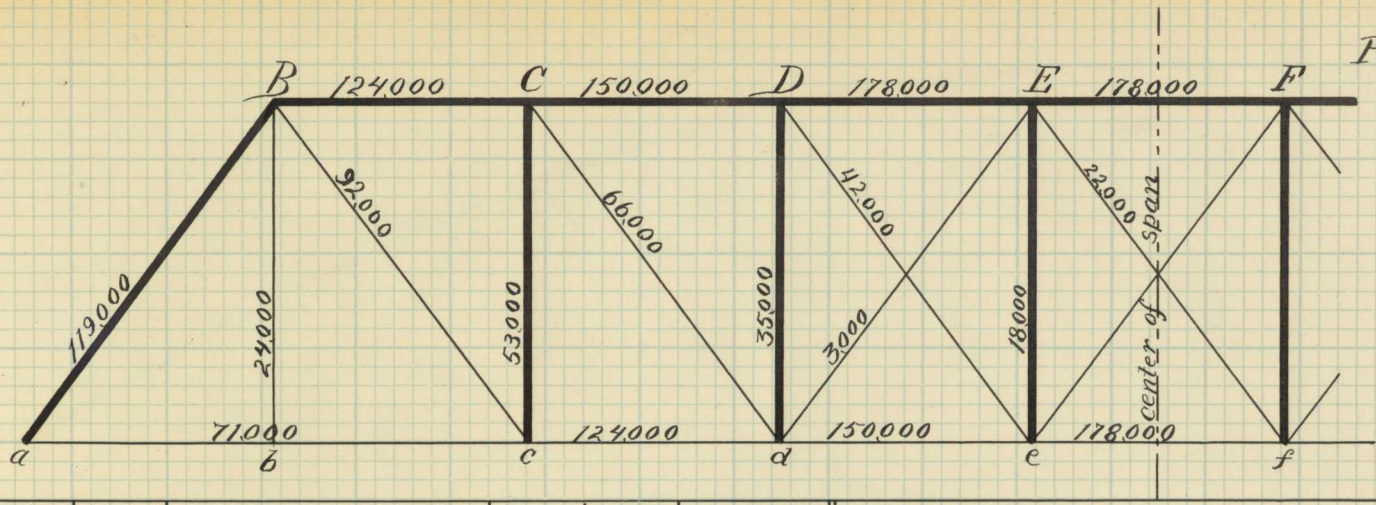


Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B-C	24.0	{Pl. 16" × 3/8" 2-12" L's @ 30#	80.0	90.6	7248	Span = 160'
C-D-E	19.8	{Pl-16" × 3/8" 2-12" L's @ 23#	66.0	81.8	5399	Roadway = 16'
C-c	2.9	4-2" × 2" L's @ 2.4#	9.6	41.6	399	No of Panels = 8
D-d	4.2	4-2" × 2½" L's @ 3.5#	14.0	52.0	728	Depth of Arch = 28'
E-e	4.8	4-2" × 3" L's @ 4#	16.0	28.0	448	L.L. per sq. ft. of Fl. = 100#
B.Ch'd	13.4	4-3½" × 15/16"	43.8	180.0	7884	" " " panel per truss = 16000#
B-b	2.3	2-1⅛" □	7.5	28.6	214	D.L. " " " " = 7500#
B-c	1.4	2-15/16" ○	4.6	52.0	239	Factor of Safty = 5
b-C-d	1.7	2-1" ○	5.2	125.6	653	
c-D-e	1.9	2-1⅛" ○	6.6	142.0	937	
a-E	2.0	2-1⅛" ○	6.6	74.0	488	
					24637	
					49274	
		Wgt. per lin. ft. =			308	



Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B-C	24.0	{Pl. 16"×3/8" 2-12" Ls @ 30#}	80.0	83.6	6688	Span = 160'
C-D-E	19.8	{Pl. 16"×3/8" 2-12" Ls @ 23#}	66.0	81.0	5346	Roadway = 16'
B-b, C-c	2.9	4-2"×2" Ls @ 2.4#	9.6	65.0	624	No of Panels = 8
D-d, E-e	4.2	4-2"×2½" Ls @ 3.5#	14.0	79.2	1109	Depth of Arch = 28'
a-a'		Same as C-D	66.0	28.0	1848	L. L. per sq ft. of Fl = 100#
B-C h'd	13.7	4-4½"×3/4"	45.0	184.6	8307	" " " panel per truss = 16000#
B-c	1.5	2-1" ○	5.2	114.0	593	D. L. " " " " = 7500#
C-d	1.7	2-1½" ○	5.9	132.0	779	Factor of Safty = 5
D-e	1.9	2-1⅝" ○	6.6	142.8	943	
					26237	
					52474	
		Wgt. per lin. ft. =			328	

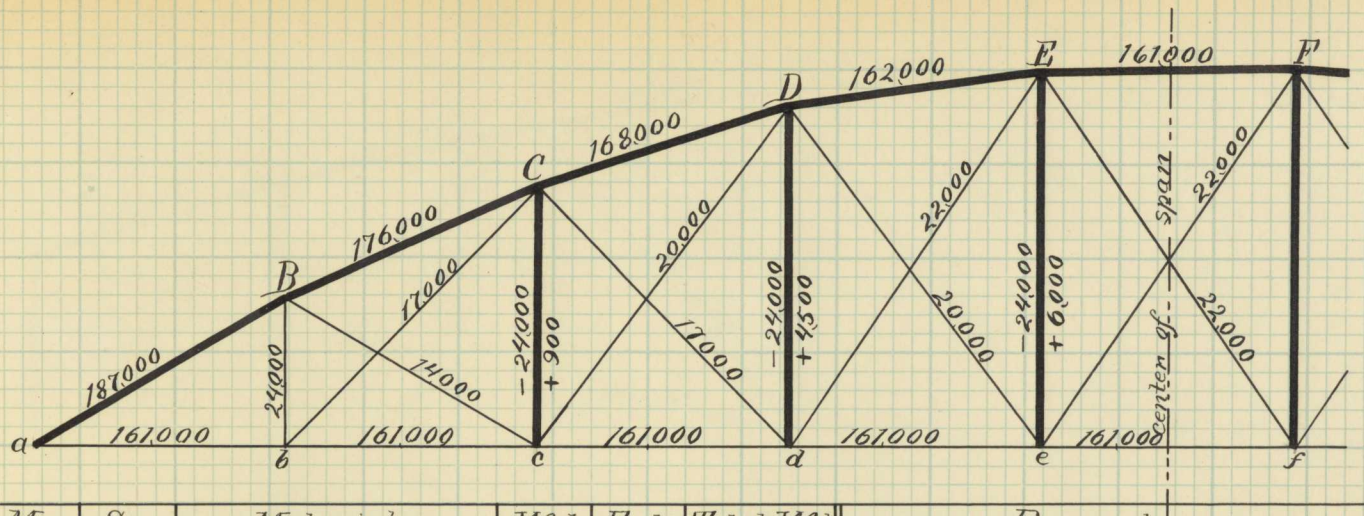
Plate XXVIII



Mem.	Sec.	Material	Wgt.	Feet	Total Wgt.
a-B	21.0	{Pl 16" x 3/8" 2-12" L's @ 25#}	70.0	67.2	4704
B-C	17.0	{Pl 16" x 5/16" 2-12" L's @ 20#}	56.7	40.0	2268
C-D	19.5	{Pl. 16" x 3/8" 2-12" L's @ 22.5#}	65.0	40.0	2600
D-F	23.0	{Pl 16" x 5/16" 2-12" L's @ 30#}	76.7	60.0	4602
C-c	9.6	2-10" L's @ 16#	32.0	54.0	1728
D-d	8.0	2-8" L's @ 13.5#	27.0	54.0	1458
E-e	4.5	2-6" L's @ 7.5#	15.0	54.0	810
a-b-c	7.1	2-3½" x 1"	23.3	92.0	2144
c-d	12.4	4-3" x 1"	40.0	46.0	1840
d-e	15.0	4 3¾" x 1"	50.0	46.0	2300
e-f	17.8	4-4½" x 1"	60.0	23.0	1380
B-b	2.5	2-1⅛" □	8.4	60.0	504
B-c	9.2	2-4¼" x 1 1/16"	31.0	73.0	2263
C-d	6.6	2-3½" x 15/16"	21.9	73.0	1502
D-e	4.2	2-2¾" x ¾"	13.8	73.0	1007
E-f	2.2	2-1 1/16" □	7.5	73.0	547
E-a	0.3	1-¾" ○	1.5	73.0	109
					31766
					63532
		Wgt. per lin. ft. =			353

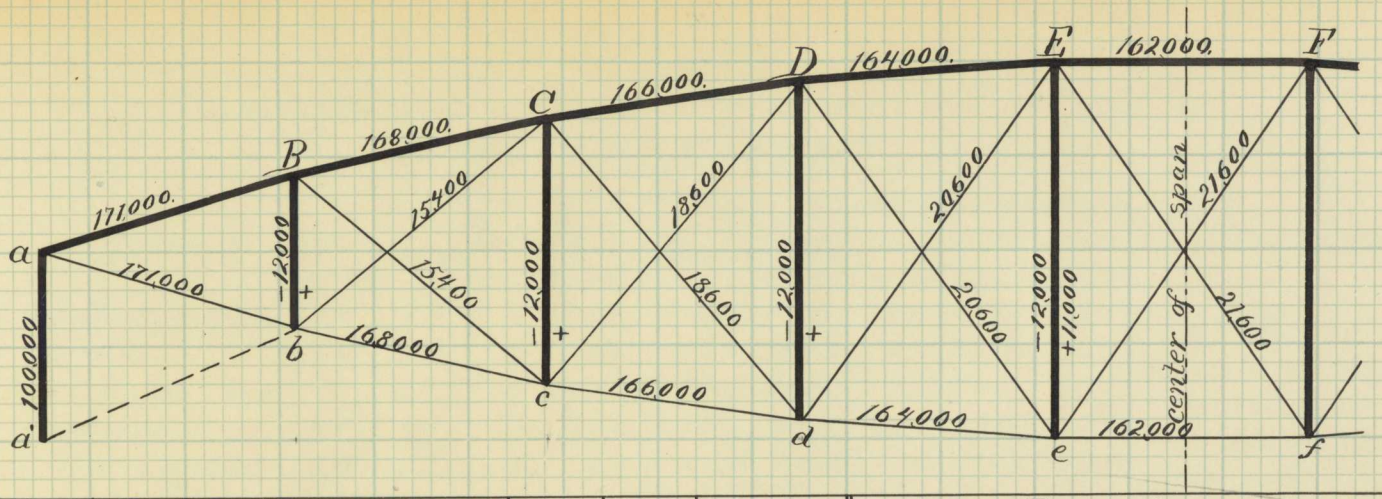
Span = 180'
Roadway = 16'
No. of Panels = 9
Depth of Truss = 27'
L. L. per sq. ft. of Fl. = 100#
" " " panel per truss = 16000#
D L. " " " " = 8000#
Factor of Safty = 5

Plate XXIX



Mem.	Sec.	Material	Wgt.	Feet	Total Wgt	Remarks
a-B	27.0	{Pl. 18" × 1/2" 2-12" L's @ 30#}	90.0	46.8	4212	Span = 180'
B-C	25.9	{Pl. 18" × 7/16" 2-12" L's @ 30#}	86.3	43.6	3763	Roadway = 16'
C-D	24.8	{Pl. 18" × 3/8" 2-12" L's @ 30#}	82.5	42.0	3465	No of Panels = 9
D-E-F	23.6	{Pl. 18" × 5/16" 2-12" L's @ 30#}	78.7	60.6	4769	Depth of Arch = 30'
C-c	4.2	4-2 1/2" × 2" L's @ 3.5#	14.0	41.0	574	L. L. per sq. ft. of Fl. = 100#
D-d	4.2	4-2 1/2" × 2" L's @ 3.5#	14.0	54.0	756	" " " panel per truss = 16000#
E-e	4.8	4-2" × 3" L's @ 4.#	16.0	59.6	954	D. L. " " " " = 8000#
B.Ch'd	16.1	4-4" × 1"	53.8	200.0	10660	Factor of Safty = 5
B-b	2.4	2-1 1/4" O	8.2	28.0	230	
B-c	1.4	2-15/16" O	4.6	51.8	238	
b-C-d	1.7	2-9/16" □	5.9	124.0	732	
C-D-e	2.0	2-1" □	6.7	143.0	958	
d-E-f	2.2	2-1 3/16" O	7.4	152.0	1125	
					32436	
					64872	
		Wgt. per lin. ft. =			360.5	

Plate XXX



Mem	Sec.	Material	Wgt.	Feet	Total Wgt.	Remarks
a-B-C-D	24.8	{Pl. 18" × 3/8" 2-12" L's @ 30#}	82.5	123.0	10148	Span = 180'
D-E-F	23.6	{Pl. 18" × 5/16" 2-12" L's @ 30#}	78.7	60.2	4738	Roadway = 16'
B-b	2.5	4-1 3/4" × 1 3/4" L's @ 2.1#	8.4	23.4	196	No of Panels = 9
C-c	4.2	4-2" × 2 1/2" L's @ 3.5#	14.0	41.6	582	Depth of Arch = 30'
D-d	4.8	4-2" × 3" L's @ 4#	16.0	53.0	848	L. L. per sq. ft. of Fl. = 100#
E-e	5.3	4-2 1/2" × 3" L's @ 4.4#	17.6	58.4	1028	" " " panel per truss = 16000#
a-a'		Same as D-E-F	78.7	30.0	2361	D. L. " " " " = 8000#
a-b-c-d	17.0	4-4 1/2" × 1"	56.7	138.0	7885	Factor of Safty = 5
d-e-f	16.0	4-4" × 1"	53.3	68.0	3624	
B-c	1.5	2-1" ○	5.2	112.0	582	
C-d	1.9	2-1 1/8" ○	6.6	134.0	884	
D-e	2.1	2-1" □	6.7	147.0	985	
E-f	2.2	2-1 3/16" ○	7.4	75.0	555	
					34416	
					68832	
		Wgt. per lin. ft. =			382	

TABLES

Showing Weights of Materials, per lineal foot of Span, for Different Types of Trusses.

Plate	Type of Truss	Span in feet	Weight of Iron					Total Wgt. of Lumber	Estimated Dead Load	Assumed Dead Load	Remarks
			Trusses	†Lateral System	Floor System	*Details	Total Iron				
I	Low Pratt, Half-Hip	40	73	5	60	18	156	195	351	380	*Details for 40' span taken at 25% of trusses. *Details for 60' span = 20% 80' " = 15% 100' " = 15% 120' " = 12% †Lateral system = 30# for high truss of 100' span, and an increase of 5# for each additional 20'.
II	" "	40	78	5	60	19.5	162.5	195	357.5	380	
III	Double Parabolic Arch	40	82.5	5	60	20.5	168	195	363	380	
IV	High Pratt	60	96	25	56	19	196	230	426	420	
V	Low Pratt - Half-Hip	60	117.5	5	56	23.5	202	230	432	420	
VI	" "	60	119.	5	56	24.	204	230	434	420	
VII	Parabolic Arch	60	123.	5	56	24.5	208.5	230	438.5	420	
VIII	Double " "	60	133	5	56	26.5	220.5	230	450.5	420	
IX	High Pratt	80	125	30	55.5	18.5	229.	240	469	490	
X	Parabolic Arch	80	157.5	6	55.5	23.5	242.5	240	482.5	490	
XI	Double " "	80	161	30	55.5	24	270.5	240	510.5	490	
XII	Low Pratt - Half-Hip	80	172.5	6	55.5	26	260.	240	500.	490	
XIII	" "	80	176.0	6	55.5	26.5	264.5	240	504	490	
XIV	High Pratt	100	169.5	30	62.	25.5	287	300	587	600	
XV	Double Parabolic Arch	100	195	30	53	29.	307	260	567	600	
XVI	" "	100	196.5	30	53	29.5	309	260	569	600	
XVII	Low Pratt - Half-Hip	100	233	6	53	35	327	260	587	600	
XVIII	" "	100	241.5	6	53	36	336.5	260	596.5	600	
XIX	High Pratt	120	202	35	62	24	323	300	623	620	
XX	Parabolic Arch	120	228	35	62	27	352	300	652	620	
XXI	Double " "	120	233.5	35	62	28	358.5	300	658.5	620	

TABLES

Showing Weights of Materials, per lineal foot of Span, for Different Types of Trusses.

Plate	Type of Truss	Span	Weight of Iron					Total Wgt. of Lumber	Actual Dead Load	Assumed Dead Load	Remarks
			Trusses	Lateral System	Floor System	* Details	Total Iron				
XXII	High Pratt	140	256	40	62	30.5	388.5	300	688.5	700	*Details for
XXIII	Parabolic Arch	140	266	40	62	32	400.	300	700	700	140' span = 12 %
XXIV	Double " "	140	284	40	62	34	420	300	720	700	160' " = 10 %
XXV	High Pratt	160	307	45	62	30.5	444.5	300	744.5	750	180' " = 10 %
XXVI	Parabolic Arch	160	308	45	62	31.	446	300	746	750	
XXVII	Double " "	160	328	45	62	33	468	300	768	750	
XXVIII	High Pratt	180	353	50	62	35.5	500.5	300	800.5	800	
XXIX	Parabolic Arch	180	360.5	50	62	36.	508.5	300	808.5	800	
XXX	Double " "	180	382	50	62	38	532	300	832	800	